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Fieldwork

Sampling Methane Seeps and Plumes on the U.S. Atlantic Margin

By Gerry Hatcher, Jenny White, Pete Dal Ferro, and Carolyn Ruppel

Scientists from the U.S. Geological Survey (USGS) Gas Hydrates Project, Oregon State University, and GEOMAR Helmholtz Centre for Ocean Research in Kiel, Germany, recently completed a research cruise on the research vessel (R/V) *Hugh R. Sharp* to acquire sediment and water samples, heat-flow data, and geophysical imagery to better understand methane dynamics on the northern U.S. Atlantic margin.

The cruise, which was supported by the U.S. Department of Energy, built on data collected during an April 2015 cruise (<**http://soundwaves.usgs.gov/2015/06/fieldwork3.html**>) that focused on acquiring geophysical constraints on methane dynamics on the same part of the margin. In 2014, **Carolyn Ruppel**, chief of the USGS Gas Hydrates Project (<**http://woodshole.er.usgs.gov/project-pages/hydrates/**>) based at the Woods Hole Coastal and Marine Science Center (WHCMSC), and **Daniel Brothers**, a geophysicist based at the Pacific Coastal and Marine Science Center (PCMSC), coauthored a study that described 570 previously unknown methane seeps on the upper continental slope in this area (see <**http://soundwaves.usgs.gov/2014/10/**>).

The September 2015 R/V *Sharp* cruise featured unique uses of data and instrumentation that were relatively new to the USGS. Because sampling operations are safer in daylight but geophysical data can be collected day or night, the researchers used the night-time hours to collect high-resolution subbottom imagery and water-column imagery of methane plumes. The following day, they returned to locations identified during the previous night to collect piston cores, multicores, heat-flow measurements, and water-column samples for dissolved methane. Subbottom imagery (cross-sectional views of sediment layers and other features beneath the seafloor) was acquired with the WHCMSC Edgetech SB-512 Chirp instrument, which emits an acoustic pulse and receives the return signal in a single "fish" towed at approximately 10 meters below the sea surface (learn more about subbottom profiling at <**http://oceanexplorer.noaa.gov/okeanos/explorations/ex1404/logs/sept24/sept24.html**>). A Simrad EK60 echo sounder equipped with a 38 kHz split-beam transducer that was mounted in the R/V *Sharp*'s retractable keel was operated nearly continuously to locate methane plumes in the water column. Repeated EK60 surveys were conducted over certain seep fields to measure how long the methane plumes persisted over hours and days. **Bill Danforth** and **Eric Moore**, both of WHCMSC, were responsible for acquisition and processing of both echo sounder and Chirp data.

A major focus of the cruise was piston coring carried out under the direction of **Pete Dal Ferro** and **Jenny White**

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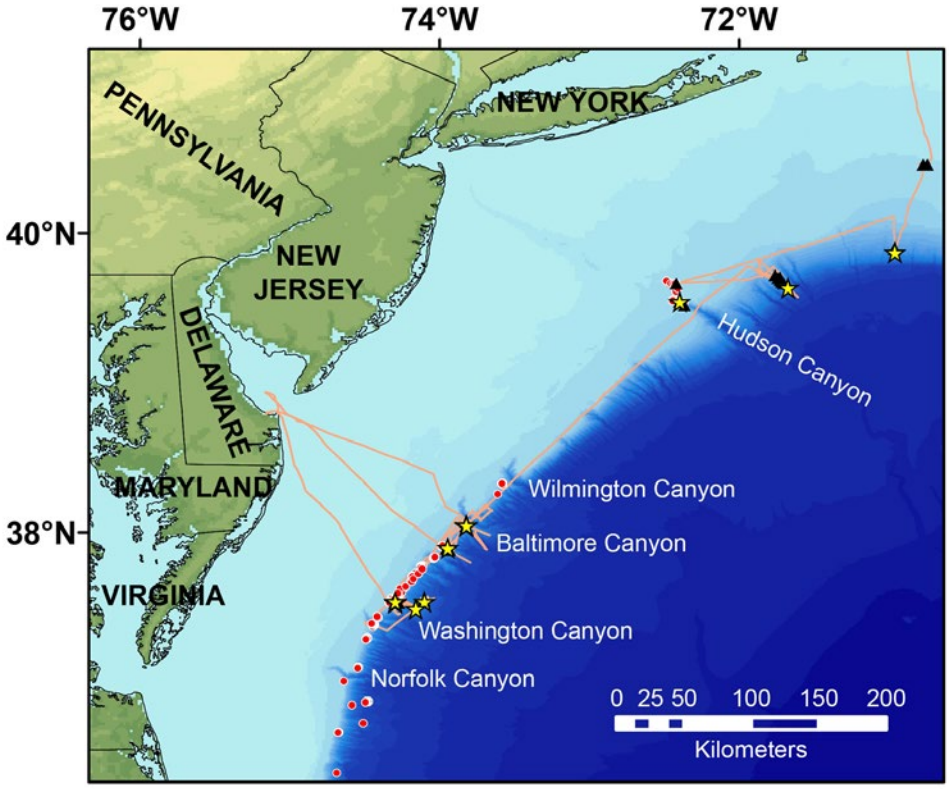

*Northern U.S. Atlantic margin, showing major canyons that cut through the continental shelf (light blue), seeps identified in 2014 (red circles; see <**http://dx.doi.org/10.1038/ngeo2232**>), and piston cores (black triangles) and multicores (stars) acquired on the research vessel (R/V)* Hugh R. Sharp *in September 2015. Cruise track is shown in orange. Many of the multicore sites coincide with piston-core sites and obscure the piston-core sites on the map.*

Sound Waves

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Publications: When new publications or products are released, please notify the editor with a full reference and a bulleted summary or description.
Images: Please submit all images at publication size (column, 2-column, or page width). Resolution of 200 to 300 dpi (dots per inch) is best. Adobe Illustrator© files or EPS files work well with vector files (such as graphs or diagrams). TIFF and JPEG files work well with raster files (photographs or rasterized vector files).

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Fieldwork, continued

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Jenny White *and* ***Pete Dal Ferro*** *deploying a piston core from the stern of the R/V* Sharp. *USGS photograph by* ***Gerry Hatcher****.*

(PCMSC). Twenty-one piston cores were collected in seep and pockmark fields (pockmarks are shallow seafloor depressions thought to be related to past methane expulsion events), on upper continental slope transects, and in Hudson Canyon (see map, page 1). These cores recovered a total of nearly 100 meters of sediment at water depths of 80 to 1,150 meters. **Brian Buczkowski** (WHCMSC) tracked subsampling of the cores, a process in which core material was extracted for detailed study to meet physical, geotechnical, microbiological, and geochemical cruise objectives. A biogeochemistry team led by **John Pohlman** (WHCMSC) and including **Michael Casso** and **Lee-Gray Boze** from WHCMSC and **David Brankovits** from Texas A&M University at Galveston segmented recovered piston cores to extract pore waters, study methane distributions, and provide subsamples to microbiologists **Frederick Colwell** and **Michael Graw** (Oregon State University) and **Stefan Krause** (GEOMAR). On many piston core deployments, sediment temperatures were measured using self-logging thermistors (temperature sensors) attached to the piston core barrels. The thermistors were loaned by **Andy Fisher** (University of California–Santa Cruz), who maintains the instrumentation as part of a National Science Foundation-sponsored community facility.

The cruise marked the first USGS deployment of a mini-multicorer, the Mini Muc (pronounced "mini muck"), a 4-core system built by K.U.M. Umwelt and Meerestechnik Kiel GmbH and loaned to the USGS by **Tina Treude**, a geomicrobiologist at University of California, Los Angeles, and a project collaborator. Multicorers are often used to retrieve high-quality, barely disturbed samples of near-seafloor sediment for microbiological, biogeochemical, and paleoceanographic studies. The Mini Muc uses 60-centimeter-long and 5-millimeter-thick Plexiglas tubes with an inner diameter of 90 millimeters. Compared with other multicore systems used in the U.S. research fleet, the Mini Muc requires substantially less deck space and is a lighter, more maneuverable instrument package.

An important component of multicoring is seafloor visualization to ascertain the proximity of cores to methane seeps, bacterial mats, and other features. For the Mini Muc deployments, **Gerry Hatcher** (PCMSC) designed a real-time high-definition (HD) camera system that was mounted on the Mini Muc frame. The camera sys-

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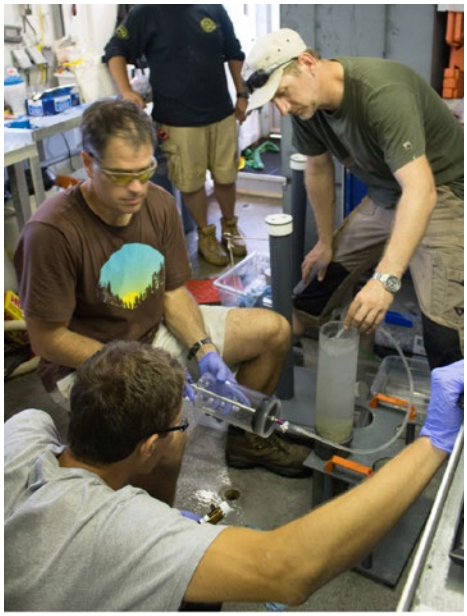
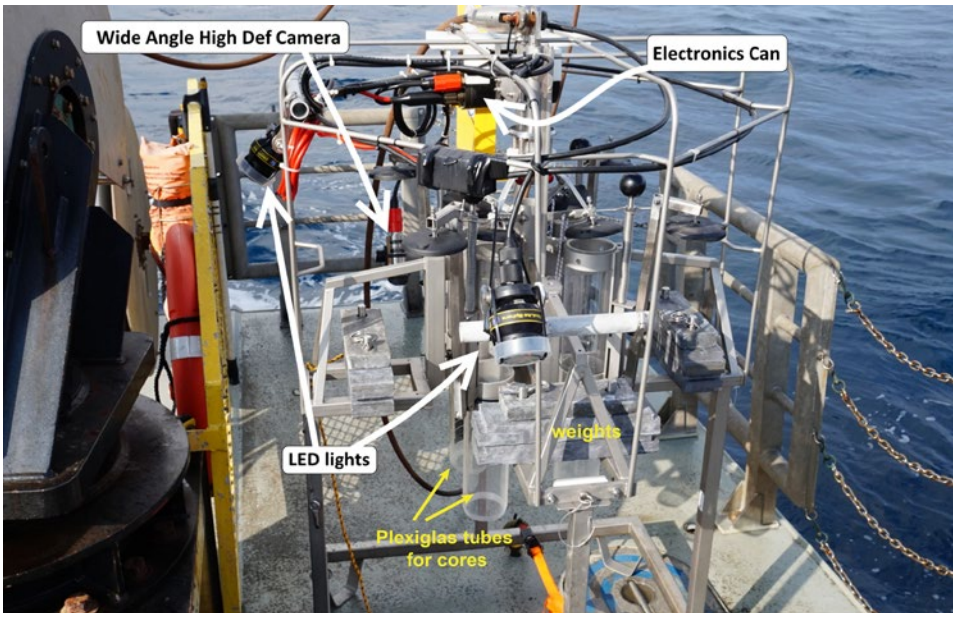


(Clockwise from bottom) ***David Brankovits*** *(Texas A&M University at Galveston),* ***John Pohlman*** *(USGS), and* ***Stefan Krause*** *(GEOMAR Helmholtz Centre for Ocean Research) collect some of the overlying water of a multicore in order to extract methane and carbon dioxide for onboard stable carbon isotope and concentration analysis with a laser-based analytical system under development at the USGS Woods Hole Coastal and Marine Science Center. Photograph by* ***Michael Graw****, Oregon State University.*

(Sampling Methane continued from page 3)



*The Mini Muc on deck, with major components of the real-time video system labeled. The footprint of the system is approximately 1 square meter. USGS figure by **Gerry Hatcher** and **Carolyn Ruppel**.*

tem consisted of two SeaLite Sphere LED Lights, an HD Multi SeaCam wide-angle camera from Deepsea Power & Light, and a "control can" custom-built for the cruise. The "control can" is an underwater pressure housing containing voltage regulators and other electronics needed to power the lights and transmit the live HD-video signal over the ship's fiber-optic sea cable to the surface. Aboard the ship, the video was simultaneously viewed and recorded, with the time stamped for correlation with ship's positional data.

To collect Mini Muc samples, the vessel was first precisely maneuvered over a seafloor position. The Mini Muc, with attached camera system, was then deployed and lowered to within 1.5 meters of the seafloor using laboratory-based joystick controls. While the Mini Muc hovered above the seafloor, scientists used the live video to determine where to core. During sampling, the Mini Muc gently penetrated the sediments before core caps automatically closed over the top and bottom of the core tubes. View a video clip at <**http://soundwaves.usgs.gov/2015/11/**>.

The live video capability developed at the USGS for this cruise was essential to collecting high-quality cores, diagnosing equipment problems, and avoiding hard seafloor that would have damaged the equipment. The video also provided scientists with a visual record of each sample site similar to that available from a remotely operated vehicle or manned submersible, at a fraction of the cost.

***Gerry Hatcher** (left) monitors the view of the seafloor from the camera mounted on the Mini Muc and communicates with the ship's bridge while **Pete Dal Ferro** uses a remote winch control to position the Mini Muc and trigger coring. USGS photograph by **Jenny White**.*

Acknowledgments

This cruise was supported by the Methane Hydrates Research Program at the U.S. Department of Energy (DOE; <**http://energy.gov/fe/science-innovation/oil-gas-research/methane-hydrate**>). Costs for instrumentation were borne by USGS-DOE interagency agreements DE-FE0002911 and DE-FE0005806. Any use of trade, firm, or product names is for descriptive purposes only and does not imply endorsement by the U.S. Government. ❁

*Video frames showing view from camera mounted on the Mini Muc. Left, view of sediment-sampling site. Three of the four core barrels are visible on left. Line on right with pear ring (weight) at its end shows height above the seafloor: when the ring just touches the seafloor, as in this view, the bottom of the Mini Muc frame is 1.5 meter above the seafloor. Right, view after the Mini Muc has been triggered and the core barrels have sunk into the sediment. View the video clip at <**http://soundwaves.usgs.gov/2015/11/**>.*

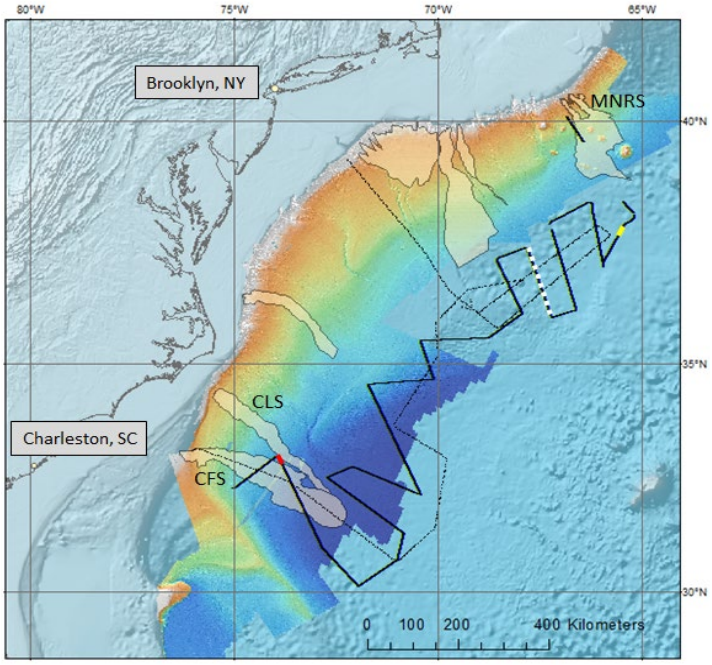
USGS Completes Second Atlantic Margin Expedition for Law of the Sea/ Submarine-Landslide Studies

By Deborah Hutchinson, Nathan Miller, and Warren Wood (Naval Research Lab)

Between April 10, 2015, and May 2, 2015, the U.S. Geological Survey (USGS) utilized the specially-equipped seismic research vessel (R/V) *Marcus G. Langseth* to collect multichannel seismic (MCS) data in deep water along the U.S. Atlantic Continental Margin between 30° and 40° N (see trackline map, below). The *Langseth*, owned by the National Science Foundation and operated by Lamont-Doherty Earth Observatory, was specially designed for both 2D and 3D multichannel seismic-reflection data acquisition. This cruise (number MGL1506) was the second of two USGS Atlantic margin surveys using *Langseth* to address the dual objectives of understanding submarine landslides and identifying the outer limits of the extended continental shelf (ECS). (For more information about the previous survey, see *Sound Waves* article "USGS Atlantic Margin Expedition Combines Submarine-Landslide Studies with Law of the Sea Mapping" <**http://soundwaves.usgs.gov/2014/12/**>.) **Warren Wood** of the U.S. Naval Research Laboratory joined this year's team as a co-chief scientist. The survey lasted 22 days, with approximately 3000 kilometers (km) of MCS tracks surveyed. Approximately 250 km of the survey covered submarine landslide objectives and the rest covered ECS objectives. In addition, gravity, magnetics, continuous multibeam echo-sounder, and chirp sub-bottom data were collected. Frequent deployment of expendable bathy-thermographs (XBTs) enabled the seismic signals in the water column to be calibrated for seismic oceanography studies for the U.S. Navy. Ports of embarkation and disembarkation were Charleston, South Carolina, and Brooklyn, New York, respectively.

For understanding submarine landslides, multichannel seismic data were collected across the width of the largest known landslide of the Atlantic margin, the Cape Fear slide (CFS), south of Cape Hatteras, North Carolina. The seismic data will provide information on the structure, stratigraphy, and relative history of failure of the slide. The Cape Fear slide extends approximately 375 km from its headwall failure near the shelf edge to its run-out toe in approximately 5,400 meters of water depth. The 2015 track lines crossed the width of the CFS obliquely twice, making two crossings/tie points (areas where the datasets overlap) with the 2014 data. Most significantly, the high-resolution data along one of the track lines show that the Cape Fear Landslide truncates the Cape Lookout landslide, and is therefore the younger of the two features (see the seismic profile, page 5). Unfortunately, a late spring storm with winds gusting above 50 knots interrupted data acquisition along the second landslide objective, the Munson-Nygren-Retriever slide complex near the New England seamounts.

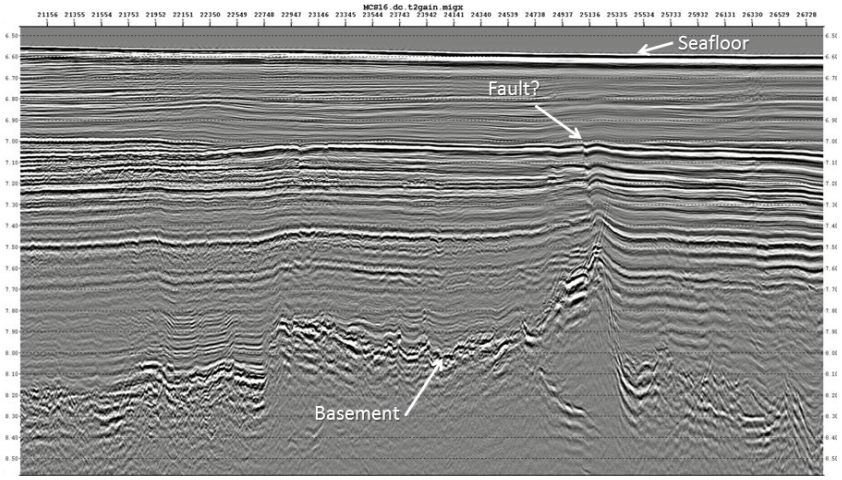
(Atlantic Margin continued on page 5)



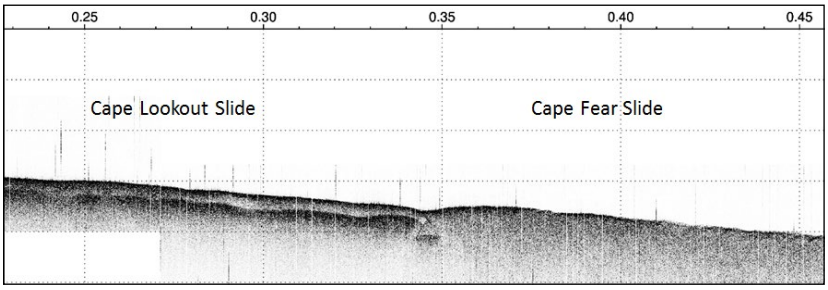
Map showing track line locations of the 2015 Langseth *survey (solid black line), locations of 2014* Langseth *survey (dotted black line), major submarine landslides (tan), and locations of seismic profiles (red line, yellow line, and dashed white-and-black line) shown in subsequent figures. CFS, Cape Fear Landslide; CLS, Cape Lookout Landslide; MNRS, Munson-Nygren-Retriever slide complex.*

MGL1506 cruise participants. Standing, left to right: ***Ray Sliter*** *(USGS),* ***Debbie Hutchinson*** *(USGS),* ***Josh Kasinger*** *(Lamont-Doherty Earth Observatory [LDEO]),* ***Roberto Henriquez*** *(LDEO),* ***Mike Martello*** *(LDEO),* ***Wayne Baldwin*** *(USGS),* ***Gilles Guerin*** *(LDEO),* ***Tom Spoto*** *(LDEO),* ***David Martinson*** *(LDEO),* ***Matt Arsenault*** *(USGS),* ***Nathan Miller*** *(USGS),* ***Amy Schmitt*** *(RPS, Inc.),* ***Alan Thompson*** *(LDEO),* ***Amanda Dubuque*** *(RPS, Inc.),* ***Cassadra Frey*** *(RPS, Inc.),* ***Amy Piko*** *(RPS, Inc.). Kneeling, left to right:* ***Carlos Gutierrez*** *(LDEO),* ***Eric Moore*** *(USGS),* ***Warren Wood*** *(U.S. Naval Research Laboratory),* ***Klatyon Curtis*** *(LDEO),* ***Claudia Portocarrero*** *(RPS, Inc.).*

(Atlantic Margin continued from page 4)



Example of multichannel seismic reflection profile showing a prominent basement ridge with a fault that extends well into the shallow part of the sedimentary section. Location is shown as the yellow line in track line location map (page 4).

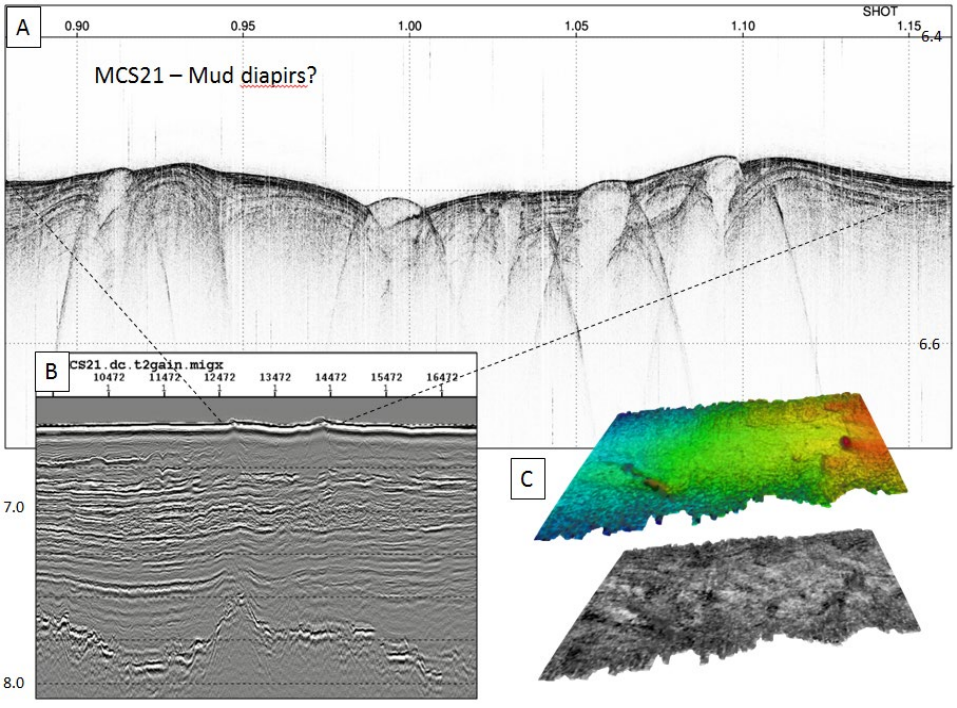


High-resolution seismic profile showing the Cape Fear Landslide truncating the Cape Lookout Landslide. Location is shown as the red line in track line location map (page 4).

For identifying the outer limits of the ECS, multichannel seismic data were collected to accurately measure sediment thickness as an input to the sediment thickness formula of Article 76 of the Convention on the Law of the Sea (<**http://www.un.org/depts/los/convention_agreements/texts/unclos/part6.htm**>). This Article enables nations to manage the seafloor and subseafloor beyond 200 nautical miles where the conditions of Article 76 are met. In 2014, the first survey collected data for ECS objectives that were primarily parallel to the trend of the margin in order to identify fracture zones or valleys where there could be local maxima in sediment thickness. The 2015 lines were primarily dip lines (in a zig-zag pattern) along these mapped or inferred trends. The seafloor and basement (i.e., top and bottom of the sediments) were imaged with great clarity on the new data (see seismic profile, left). One of the surprises in the dataset was the identification of faults in the sedimentary section, well above basement, indicating continued tectonic or other activity well after seafloor spreading began (see seismic profile, left).

Other unexpected features imaged in the data were diapir (dome)-like structures affecting the otherwise flat seafloor. These can be seen at all scales imaged, in the highest resolution chirp data, the multichannel data, and as possible flow-like features in the multibeam echosounding and backscatter swaths (see images of possible mud diapirs, below). These features occurred primarily in the vicinity of the New England seamounts, although there was no indication of the seamounts immediately around or near these features. The origin of these features appears to be shallow in the sedimentary section because deeper horizons are generally not affected.

The hard work of processing and interpreting the data is now underway! ❁



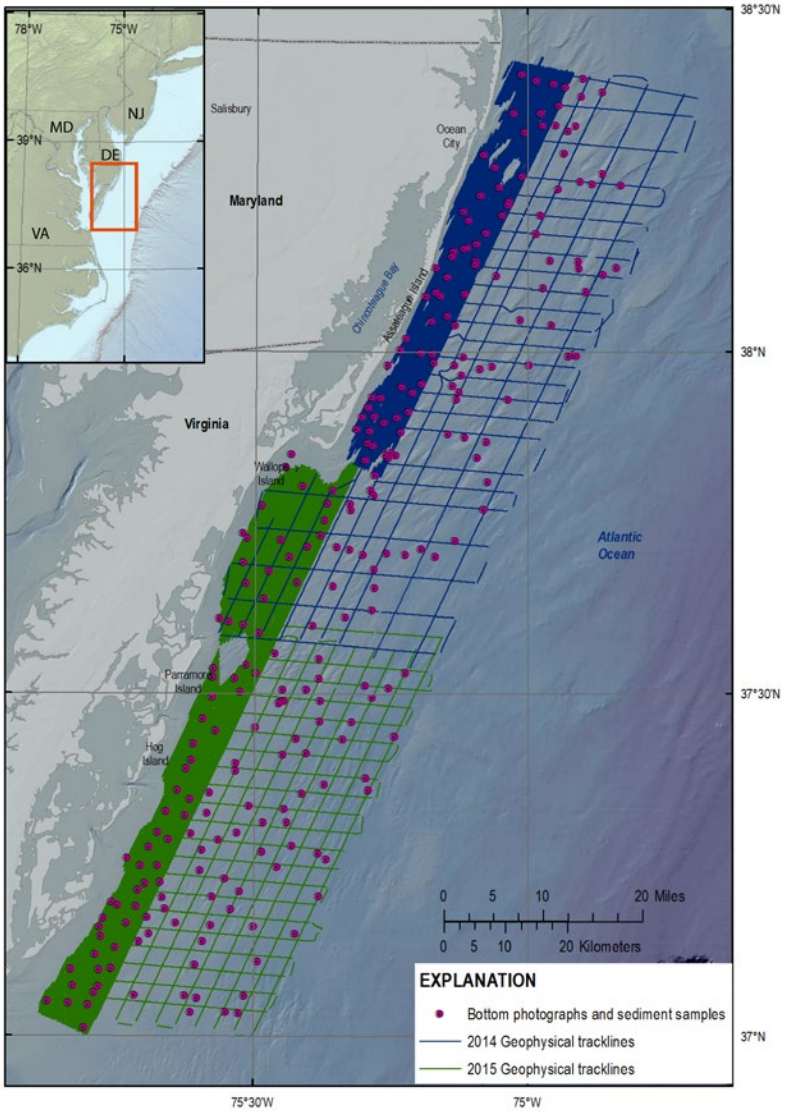
Images of possible mud diapirs discovered in deep water during the MGL1506 survey. A) High resolution seismic profile showing seafloor disturbance by these features; B) Multichannel seismic profile showing disturbance in the upper ~0.5 second two-way travel time, but no deep seated disturbance (location shown by the white dashed line in trackline map on page 4); C) Multibeam (upper) and backscatter (lower) images along the same track as (A) showing the seafloor disturbance.

"Team Delmarva" Completes Second Comprehensive Seafloor Mapping off the Delmarva Peninsula

By Laura Brothers

For 37 days this summer, scientists and engineers primarily from the U.S. Geological Survey (USGS) Woods Hole Coastal and Marine Science Center mapped the seafloor and sub seafloor of the Delmarva (Delaware, Maryland, Virginia) inner continental shelf. This completes the 2-year geophysical mapping component of the Hurricane Sandy Response Project—Linking the Delmarva Peninsula's Geologic Framework to Coastal Vulnerability (<**http://woodshole.er.usgs.gov/project-pages/delmarva/**>). Highlights of the 2015 cruise included outstanding data collection, great teamwork, wonderful weather, and a National Aeronautics and Space Administration (NASA) rocket launch.

The Delmarva Peninsula is the 220-kilometer-long headland, spit, and barrier island complex in the Mid-Atlantic consisting of the states Delaware, Maryland, and Virginia. Parts of this coastline are experiencing some of the highest rates of sea-level rise in the East Coast (<**http://woodshole.er.usgs.gov/project-pages/cvi/**>). In 2012, Hurricane Sandy severely impacted many national assets (for example, Wallops Flight Facility, Assateague Island National Seashore, Chincoteague National Wildlife Refuge) and coastal municipalities along the Delmarva Peninsula exposing the need for knowledge of the sediment sources, transport pathways, sinks that support the beach and barrier system. Comprehensive inner continental shelf geophysical mapping provides the data essential to fill these knowledge gaps. Similar efforts conducted in New York, North Carolina, South Carolina (<**http://woodshole.er.usgs.gov/project-pages/coastal_change/**>), California (<**http://walrus.wr.usgs.gov/mapping/csmp/**>), the northern Gulf of Mexico (<**http://coastal.er.usgs.gov/geo-evo/**>) and Massachusetts (**http://woodshole.er.usgs.gov/project-pages/coastal_mass/**>) have proven crucial to the assessment of coastal hazards as well as to habitat characterization and identification of cultural resources in those regions.



Location map showing the tracklines and grab sample sites of the 2014 and 2015 geophysical surveys offshore of the Delmarva Peninsula.

Aboard the 132-foot motor vessel (M/V) *Scarlett Isabella,* "Team Delmarva," consisting of **Bill Danforth**, **Emile Bergeron**, **Alex Nichols, Chuck Worley**, **Jackson Curie**, **Dave Foster**, **Brian Andrews**, **Eric Moore**, **Wayne Baldwin**, **Seth Ackerman**, and **Laura Brothers**, collected chirp and 16-channel boomer seismic reflection profiles, swath bathymetry, acoustic backscatter data and sediment samples in June-July, 2015. With amazing weather and solid equipment performance, the cruise had only 52 hours of unscheduled down time during the 6-week period. Working 12-hour shifts, 24 hours a day, in windowless lab vans filled with computers and expertise, the team collected over 5,500 kilometers (km) of geophysical data tracklines. In the last 2.5 days of the cruise, 125 samples and photos of the seafloor were collected.

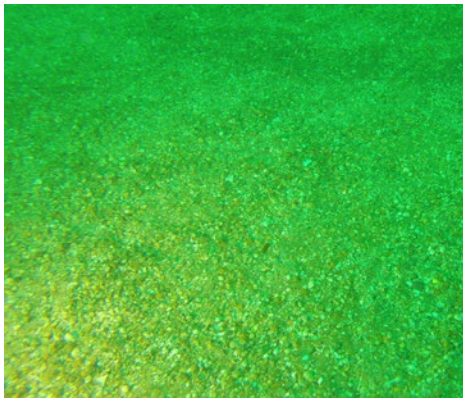
While finishing survey work in the Chincoteague Bight the morning of

("Team Delmarva" continued on page 7)

("Team Delmarva" continued from page 6)

The M/V Scarlett Isabella *towed acoustic instruments such as the 512i Chirp subbottom profiler (yellow catamaran) and Edgetech 4100 sidescan sonar (underwater). Also pictured is the winch of the Moving Vessel Profiler. The survey was conducted in water depths of 7 to 33 meters. Resembling a scene from "Finding Nemo," the vessel accrued 'hitch hikers' while surveying close to shore.*

*Big smiles in the acquisition van as **Bill Danforth, Eric Moore,** and **Alex Nichols** watch geophysical data scroll across the screens in real time.*



A photo taken with a GoPro® Camera attached to a Van Veen grab sampler reveals a seafloor composed of shell hash.

June 25, the M/V *Scarlett Isabella* was instructed to vacate the vicinity due to a rocket launch at neighboring Wallops Flight Facility. From a safe distance "Team Delmarva" had a clear view of the 6 a.m. launch of the rocket *RockOnVIII*, a suborbital rocket that carried student experiments (<**http://wavy.com/2015/06/25/nasa-launches-suborbital-rocket-with-student-experiments/**>). That event, along with the many days at sea continuously collecting and processing data, made the 2015 cruise memorable. The more than 5 terabytes of data collected during the cruise are already being examined and prepared for release and dissemination by **Elizabeth Pendleton**, **Ed Sweeney**, and **Rob Thieler**. Between 2014 and 2015, "Team Delmarva" collected trackline data along a linear distance of 10,000 km over an area of 5,700 square kilometers of the Delmarva inner continental shelf. Already, data from the 2014 survey are in use by regional stakeholders. (For more information about the 2014 survey, see *Sound Waves* article "USGS Scientists Conduct Comprehensive Seafloor Mapping off the Delmarva Peninsula" <**http://soundwaves.usgs.gov/2014/10/spotlight2.html**>.) The successful 2015 survey completes another USGS regional geophysical study that lays the groundwork for understanding coastal response to hazards. ❁

Pathways to the Abyss

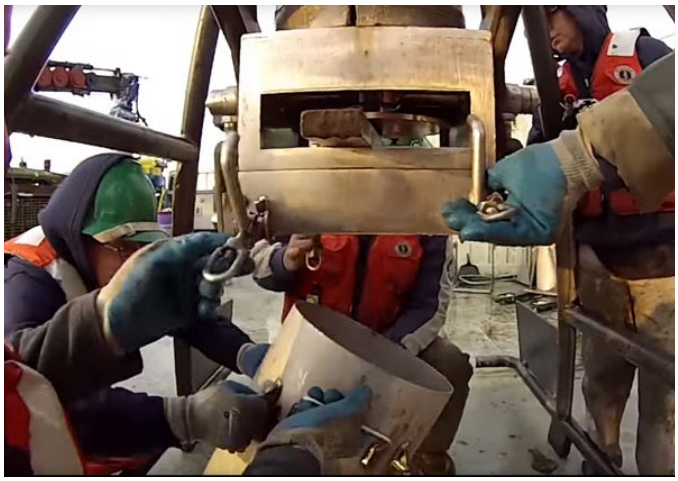
By Amanda Demopoulos and Kaitlin Kovacs

[Reprinted from USGS Science Features: Top Story, May 27, 2015, <*http://www.usgs.gov/blogs/features/usgs_top_story/pathways-to-the-abyss/*>.]

A new video by the Bureau of Ocean Energy Management (BOEM, <**https://www.youtube.com/watch?v=NS_uZX77jfs&feature=youtu.be**>) includes highlights of some of the contributions of U.S. Geological Survey (USGS) scientists during a five-year study of two deep mid-Atlantic canyons located about 150 kilometers (nearly 100 miles) offshore of Virginia and Maryland.

USGS researchers collaborated with academic and private organizations and institutions, BOEM, and the National Oceanic and Atmospheric Administra-

(Pathways continued on page 8)



*Scientists assemble a box core to collect seafloor sediment samples for biological and geological analyses in this screenshot from "Atlantic Canyons: Pathways to the Abyss," a Bureau of Ocean Energy Management (BOEM) video posted at <**http://www.boem.gov/Atlantic-Canyons-Pathways-to-the-Abyss/**>.*

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Cerianthid anemones, also known as "tube anemones," although related, are not considered true anemones. They live in a tube they build using mucus, surrounding mud, and thread-like structures produced by their cells. The two red laser dots (to the left of the center anemone) are 10 centimeters (about 6 inches) apart. Credit: NOAA-OER/BOEM/USGS

tion (NOAA) to conduct ecosystem-based science to support the responsible exploration and development of the nation's resources. This interdisciplinary, collaborative effort represents one of the most comprehensive studies of deep-sea canyons.

Deep-sea canyon habitats are complex ecosystems encompassing a range of habitat types, including soft sediment, hard substrate, and chemosynthetic seeps. Deep-sea communities provide essential ecosystem services, including carbon cycling and food for animals higher in the food webs, and important habitat for marine species. However, little is known about species composition, food webs, and habitats in these canyons.

During the expeditions, the USGS conducted research examining canyon geology, oceanography, ecology, animal and microbial distribution, and genetics to help understand the community structure, food webs, and connectivity of deep-sea canyon ecosystems—from microbes to corals to fish.

USGS researchers played an integral role in planning the offshore expeditions and provided scientific support and expertise at sea. **Amanda Demopoulos**, research benthic ecologist at the Southeast Ecological Science Center, served as the USGS project chief, coordinating research with the project's multiple principal investigators. She and **Nancy Prouty**, research oceanographer from the Pacific Coastal and Marine Science Center, led the deployment and use of deep-sea moorings; these provided continuous year-long records of the canyon environment and the flow of food resources to the seafloor. **Jason Chaytor** and **Uri ten Brink** of the Woods Hole Coastal and Marine Science Center, and **Daniel Brothers** from the Pacific Coastal and Marine Science Center, created detailed maps of the two canyons by processing and interpreting multibeam mapping data. These maps proved to be critical to expedition planning.

Demopoulos provided expertise on understanding the animals living within the canyon environments and associated linkages among these organisms. Prouty

(Pathways continued on page 9)

***Christina Kellogg** (left) and **Amanda Demopoulos** collect sediment core samples from a box core upon its return from the deep-sea canyon seafloor. Credit: NOAA-OER/BOEM/USGS*

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***Cheryl Morrison** removes specimens collected by the remotely operated vehicle (ROV)* Jason. *Credit: NOAA-OER/BOEM/USGS*

estimated the ages of deep-sea corals, using the skeletons to provide a history of oceanographic conditions in the region. **Cheryl Morrison**, research geneticist from Leetown Science Center, examined population and conservation genetics of deep-sea corals and crustaceans. **Christina Kellogg**, research microbiologist from the St. Petersburg Coastal and Marine Science Center, provided expertise in understanding the microbial ecology of deep-sea corals and canyon sediment.

Due to the challenging nature of working in these remote systems, the USGS researchers developed novel approaches and applied innovative technologies. For example, they used high-resolution multibeam mapping, instrumented moorings, and molecular, stable isotope, and trace element techniques to observe, sample, and conduct experiments within the deep sea. The use of these techniques is enhancing knowledge of critical deep-sea habitats across broad spatial scales (10s to 1,000s of kilometers) and depth ranges (350 to 2,200 meters).

***Nancy Prouty** retrieves water samples from a CTD (Conductivity Temperature Depth profiler) rosette, which collects environmental data and water samples to inform scientists on water conditions at various depths. Credit: NOAA-OER/BOEM/USGS*

Deep-sea corals found in the canyons are slow-growing and long-lived, with many living more than 100 years. They are extremely vulnerable to disturbance and slow to recover. Certain species of deep-sea corals exhibit differing patterns of connectivity, which has implications for the type of conservation strategy that may be applied to these vulnerable species. Examination of the coral-associated microbes suggests that microbes and corals may share similar biogeographic patterns.

Discrete animal communities were found inside the canyons that differed from those found on adjacent slopes, which indicates the canyons are serving as complex habitats supporting diverse communities. Canyons contain complex food webs thriving on food produced in surface waters. By developing long-term deep-sea observatories (moorings), the USGS investigators can better understand how the canyon environment may influence deep-sea canyon biodiversity and community function.

This pioneering research characterizing deep-sea communities across regions and habitats has allowed for the evaluation of ecosystem change by establishing critical baselines for deep-sea ecosystem health; these baselines help scientists measure changes caused by both natural and human disturbances. By addressing USGS' vision of integrated science and assessment, this research supports ecosystem-based management by improving understanding of the ecology of significant, vulnerable, yet poorly understood biological communities.

The multiagency project was selected for the 2013 Department of the Interior Partners in Conservation Award (<**http://soundwaves.usgs.gov/2014/02/awards.html**>) for its outstanding contributions to addressing and achieving conservation objectives via collaboration and partnering.

For more information on the video and partnership, read the BOEM news release at <**http://www.boem.gov/press05272015/**>. View the video on the BOEM website at <**http://www.boem.gov/Atlantic-Canyons-Pathways-to-the-Abyss/**>. ❁

USGS Residual Oil Research Presented at Two Public Seminars

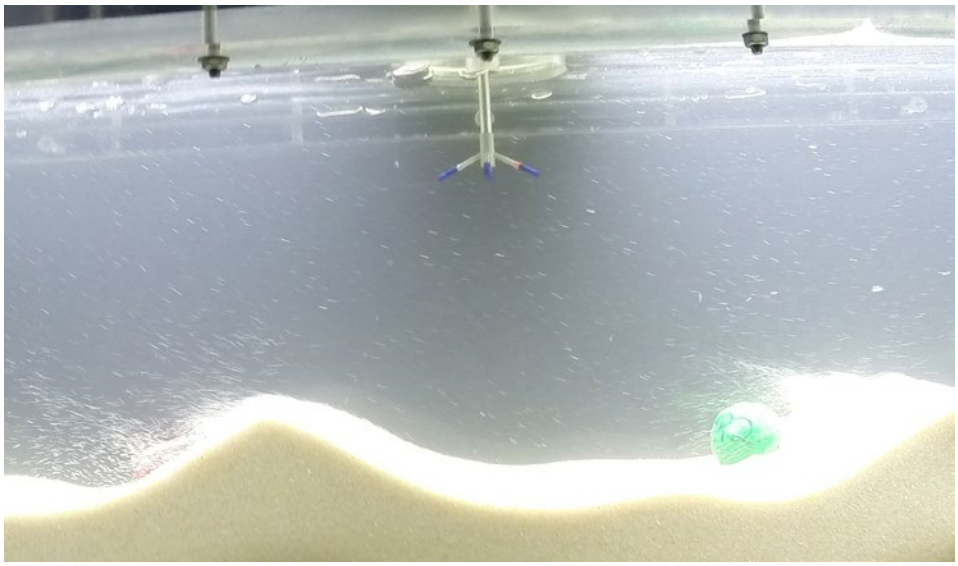
By P. Soupy Dalyander

U.S. Geological Survey (USGS) oceanographer **Soupy Dalyander** recently presented residual oil research at two public seminars organized to inform natural resource managers, oil spill responders, and the public on scientific understanding of oil spills.

During the *Deepwater Horizon* spill, floating oil that came into the surf zone of the northern Gulf of Mexico mixed with sediment to form sand and oil agglomerates (SOAs) or "sinking tarballs." USGS research has focused on the physical dynamics of SOAs, which were a persistent mechanism of beach oiling following *Deepwater Horizon*. Research was initiated in 2012 at the request of the Federal On-Scene Coordinator (the representative of the U.S. Coast Guard overseeing the clean-up response to the *Deepwater Horizon* spill), who asked USGS scientists to participate in the Operational Science Advisory Team (OSAT3), which was tasked with developing and applying a method for evaluating the movement and seafloor interaction of SOAs to facilitate their clean up. For that initial effort, numerical model output and sediment mobility and transport formulations were used to predict the seafloor interaction and transport of SOAs. Key findings, including identifying a high probability of SOA burial and exhumation, determining probable longshore transport patterns, and identifying inlets as likely traps of SOAs, were used to inform the clean-up response. The USGS has since continued to work on reducing uncertainty in the developed formulations through field and laboratory studies of artificial sand and oil agglomerates (aSOAs, below). (A *Sound Waves* article about this work was published in 2014 at <**http://soundwaves.usgs.gov/2014/06/research.html**>.)

The results of this research and how the developed formulations were applied in response to the *Deepwater Horizon* were presented at two forums. The first seminar "Oil Spill Science Seminar: Impacts of Oil on Coastal Habitats" (<**https://gulfseagrant.wordpress.com/oilspilloutreach/presentations/oil-spill-science-seminar-impacts-of-oil-on-coastal-habitats/**>) was hosted by the Gulf of Mexico Sea Grant Oil Spill Outreach Team and the Florida Department of Environmental Protection on July 22, 2015, in Temple Terrace, Florida. The second seminar "Navigating Shifting Sands: Oil on our Beaches" (<**https://gulfseagrant.wordpress.com/oilspilloutreach/presentations/oil-spill-science-seminar-navigating-shifting-sands/**>) was hosted by Mississippi–Alabama Sea Grant in Pensacola, Florida, on August 5, 2015. Represented at the seminars were oil spill emergency response agencies, natural resource managers, and the public, and the agendas included presentations on oil spill research as well as open forum question and answer sessions.

Soupy Dalyander *describes research into the seafloor interaction and transport of sand and oil agglomerates (SOAs) and how numerical models built to describe those processes were used to inform the* Deepwater Horizon *clean-up effort. Photo Credit: Mississippi-Alabama Sea Grant Consortium.*



Artificial sand and oil agglomerates (aSOAs) deployed in a small-scale oscillatory flow tank at the Naval Research Laboratory. Under the flow conditions displayed, the immobile 5-centimeter diameter aSOAs in the tank were buried by migrating sand ripples.

The full citations for research presented at the seminars are:

Plant, N.G., Long, J.W., Dalyander, P.S., Thompson, D.M., Raabe, E.A., 2013, Application of a hydrodynamic and sediment transport model for guidance of response efforts related to the *Deepwater Horizon* oil spill in the Northern Gulf of Mexico along the coast of Alabama and Florida: U.S. Geological Survey Open-File Report 2012–1234, 46 p. [**http://pubs.usgs.gov/of/2012/1234/**].

Dalyander, P.S., Long, J.W., Plant, N.G., Thompson, D.M., 2014, Assessing mobility and redistribution patterns of sand and oil agglomerates in the surf zone: Marine Pollution Bulletin, v. 80, no. 1–2, p. 200–209 [**http://dx.doi.org/10.1016/j.marpolbul.2014.01.004**].

Dalyander, P.S., Plant, N.G., Long, J.W., McLaughlin, M., 2015, Nearshore dynamics of artificial sand and oil agglomerates: Marine Pollution Bulletin, v. 96, no. 1–2, p. 344–355 [**http://dx.doi.org/10.1016/j.marpolbul.2015.04.049**]. ❁

USGS Hosts University of South Florida Oceanography Camp for Girls

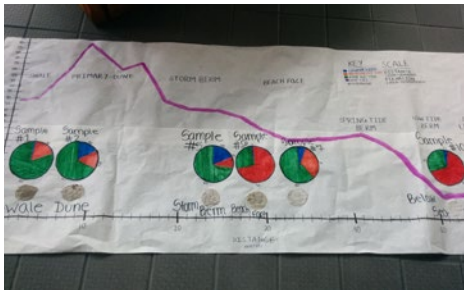
By Kira Barerra

On July 1 and 2, 2015, the U.S. Geological Survey (USGS) St. Petersburg Coastal and Marine Science Center (SPCMSC) hosted the University of South Florida College of Marine Science Oceanography Camp for Girls (<**http://www.marine.usf.edu/girlscamp/index.shtml**>). The camp was developed in the 1990s to inspire and motivate young women entering high school to consider career opportunities in the sciences. The USGS has been participating in the program for 16 years (for example, see <**http://soundwaves.usgs.gov/2004/07/outreach5.html**>) and is their longest continuous community partner .

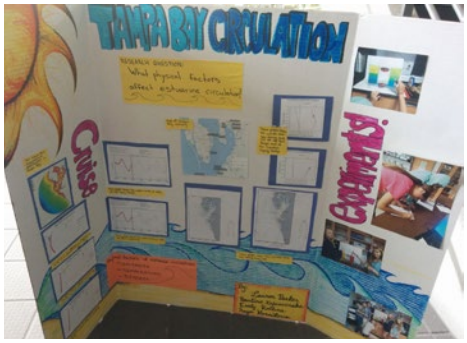
The 30 campers toured the SPCMSC, where they learned about laboratory procedures and analysis, watched demonstrations of a variety of scientific instruments and equipment, and toured marine research vessels. To give the campers the opportunity to interact and engage with scientists, they met with SPCMSC director **Cheryl Hapke** and conducted career interviews of USGS scientists **Nathaniel Plant**, **Alisha Ellis**, **Rangley Mickey**, **Jacquelyn Overbeck**, **Kira Barrera**, **Jennifer Brown**, **Kathleen Wilson**, **Lisa Osterman**, and **Terrence McCloskey**.

SPCMSC staff members were invited to attend the camp graduation ceremony that highlighted the various research projects conducted by the young women. Several of the campers expressed inspiration and increased interest in science after their visit to the SPCMSC, as was shown by their choice of research topics, which included a sediment transport and grain size study, and a project focused on water circulation patterns in Tampa Bay. Additionally, Hapke and the SPCMSC were presented with an award honoring their commitment to encouraging the next generation of women in STEM (science, technology, engineering, and mathematics) in our community. ❁

Thomas Tuten *(Max) demonstrates sediment analysis methods in the sediment lab.*



Results of a sediment transport and grain size study research project conducted by Oceanography Camp for Girls campers.



Poster presenting the results of a research project about circulation patterns in Tampa Bay conducted by Oceanography Camp for Girls campers.

Oceanography Camp for Girls campers meet with ***Cheryl Hapke****, director of the USGS St. Petersburg Coastal and Marine Science Center.*

Oceanography Camp for Girls campers tour the USGS St. Petersburg Coastal and Marine Science Center.

Chris Reich *and* ***Kyle Kelso*** *explain sediment and coral collection methods in the core lab.*

USGS Continues Collaboration for Native Youth in Science—Preserving Our Homeland

By Ben Gutierrez and Monique Fordham

For the fourth consecutive summer, the Native Youth in Science—Preserving Our Homelands (NYS–POH) summer science camp was presented by the U.S. Geological Survey (USGS) Office of Tribal Relations and the USGS Woods Hole Coastal and Marine Science Center (WHCMSC) in collaboration with the Mashpee Wampanoag Tribe's (MWT) Departments of Education and Natural Resources, the Waquoit Bay National Estuarine Research Reserve (WBNERR), the Woods Hole Oceanographic Institution (WHOI), and the National Oceanic and Atmospheric Administration (NOAA) Northeast National Marine Fisheries Science Center.

Serving Mashpee Wampanoag students from grades five, six, and seven, this year's camp followed the format of previous years, taking place weekly during the month of July at various locations around Cape Cod, Massachusetts. Each day focused on a different topic of marine biology, geology, or environmental science relevant to the Mashpee Wampanoag homelands. In addition to the Western science perspective, Mashpee Wampanoag tribal culture keepers **Earl Mills, Jr.**, **Tony Perry**, **Melanie Roderick**, and **George "Chuckie" Green, Jr**. (Assistant Director of the Tribe's Natural Resource Department) provided traditional ecological knowledge, tribal language lessons, and discussions relevant to each day's topic. **Renee Lopes-Pocknett**, Director of the Tribe's Education Department, coordinated and presented activities designed to reinforce each day's lessons.

Ben Gutierrez and **Dann Blackwood** (WHCMSC) kicked off the program with a mapping unit, followed by a discussion of rocks and minerals, geologic time, and Cape Cod geology. They also discussed the sand and gravel composition of the lands in the Mashpee, Massachusetts, region and how they relate to the glacial outwash origin of this portion of Cape Cod. Gutierrez and Blackwood also demonstrated how these outwash sediments impact the local groundwater system, allowing for rapid groundwater transport—an important factor in nitrogen loading in Cape Cod waters. **Tony Perry** and **George Green, Jr.** (MWT) provided lessons on traditional seasonal burning practices, and how they promote indigenous species habitats, fostering their continued survival. They also emphasized how reinstituting these burning practices has contributed to the recovery of the eastern cottontail rabbit. **Christina Stringer**, a research hydrologist with the U.S. Forest Service, conducted units on the hydrologic cycle, water quality, and the significance of water quality for the health of local waterways that are vital to traditional Wampanoag food resources such as herring and shellfish. **Wayne Baldwin** (WHCMSC) conducted a day focused on exploring geologic and topographic maps to help understand Cape Cod geology. In particular, Baldwin focused on how glaciers shaped Cape Cod and contributed to the genesis of the Mashpee homeland waterways. **Earl Mills, Jr.** presented tribal stories about Maushop, the traditional cultural hero, and how he shaped the contours of the Mashpee Wampanoag homelands. **Jim Rassman** (WBNERR) led a hike along the Quashnet River, one of the waterways river herring use to migrate from the ocean to breeding grounds in local lakes and ponds. Rassman discussed the impacts of invasive species on the indigenous flora and fauna in Waquoit Bay marshes, and **Earl Mills, Jr.** identified plants traditionally utilized by the Tribe for food, medicine, and material culture. They gave students first-hand experience in contrasting developed, undeveloped and recently restored regions of the Quashnet watershed, which include natural settings, a golf course, and an abandoned cranberry bog. **Stephanie Madsen** of WHOI and a group of WHOI interns conducted a unit on salt marsh geology, identifying different grass species in marshes and showing how marshes build up over time by examining marsh core samples. Madsen and her interns also discussed how storms can transport sand eroded from barrier beaches. ❁

***Wayne Baldwin** demonstrates the use of geologic and topographic maps.*

USGS Participates in Another Year of the Woods Hole Partnership Education Program (PEP)

By Ben Gutierrez, E. Robert Thieler, and Emily Himmelstoss

For the seventh consecutive year, the U.S. Geological Survey (USGS) Woods Hole Coastal and Marine Science Center in Woods Hole, Massachusetts, continued its collaboration with five other Woods Hole science institutions as part of the Woods Hole Partnership Education Program (PEP, <**http://www.woodsholediversity.org/pep/**>). PEP provides internship opportunities for a diverse cohort of undergraduate students seeking

(Partnership Education continued on page 13)

(Partnership Education continued from page 12)

experience in the earth and ocean sciences. The other participating Woods Hole institutions include the NOAA Northeast Fisheries Science Center, the Woods Hole Oceanographic Institution, Sea Education Association, the Woods Hole Research Center, and the Marine Biological Laboratory. The University of Maryland Eastern Shore also serves as an educational partner. This year's program included 16 students from hometowns and colleges spanning the country from Hawaii to Vermont to Florida.

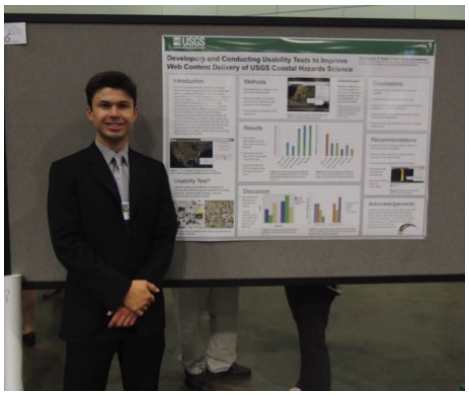
To start the summer, students took a month-long, four-credit course in global climate change and oceanography that provided overviews of the major oceanographic disciplines (biological, chemical, coastal and geological, and physical) as well as ecosystem management and policy. Each course topic included field and laboratory demonstrations and exercises that gave students a small taste of the work that scientists do to explore research questions in climate change and oceanography. Concurrently, students began working on independent research projects that were conducted under the guidance of a scientist mentor at one of the six participating Woods Hole institutions. Once the coursework finished, students focused on their research full time for the remaining six weeks of the program. Students also participated in a number of professional development seminars throughout the summer, with topics ranging from public speaking to pursuing graduate school opportunities and early career research funding. The program finished August 7, with a day-long symposium in which each student gave a formal presentation of their summer research findings.

The USGS Coastal and Marine Geology Program (CMGP) has been able to contribute to PEP through **Ben Gutierrez'** organization of the classroom and professional development portions of the program, and through direct support of a PEP student in each of the two most recent PEP cohorts. This summer, one of the PEP students, **Kent Kuehl** (California State University, Bakersfield, Geology) worked with **Rob Thieler** and **Emily Himmelstoss** to conduct usability tests of the USGS Coastal Change Hazards Portal (<**http://marine.usgs.gov/coastalchangehazardsportal/**>) that serves as an online source of information for USGS coastal hazards and sea-level rise vulnerability work. Kuehl enlisted 12 participants to use the website to complete a specific set of tasks he designed to test the interactive functionality of the website. By evaluating each participant's work and soliciting feedback regarding site functionality, Kuehl was able to suggest several website improvements, which will be considered during the next round of website development.

The 2015 PEP student class on the final day of the program. ***Kent Kuehl****, who worked at the USGS Woods Hole Coastal and Marine Science Center, is shown at the lower right with the black tie. Photo:* ***Tom Kleindinst****, Tom Kleindinst Photography.*

Kuehl continued work started by **Dion Kucera** (Humboldt State University, Environmental Studies), a 2014 PEP student also supported by CMGP. Kucera presented the results of his research at the 2014 Society for the Advancement of Chicanos and Native Americans in Science (SACNAS) National Conference in Los Angeles, California, where he also worked with the USGS team that attended the meeting to advertise PEP and other USGS diversity initiatives. Currently, Kucera is pursuing Masters of Environmental Science at Indiana University.

PEP started in 2009 through the effort of the Woods Hole Diversity Initiative (<**http://www.woodsholediversity.org/**>) which brought together the six Woods Hole science institutions to explore ways to diversify the scientific workforce. It is one of the only Woods Hole programs that includes participation from each Woods Hole science institution. As of August 2015, PEP has graduated 106 students, a number of whom went on to present their PEP research at professional meetings within a year of their internships. Many PEP students are pursuing career and educational opportunities in the sciences. Several students have returned to Woods Hole to explore new topics or continue the research they'd already started with their mentors. ❁



Dion Kucera *at the 2014 SACNAS conference in Los Angeles, California. Photo credit:* ***Onjale Scott****.*

New Production Team for *Sound Waves*

By Helen Gibbons

Please welcome **Jolene Gittens** as the new editor of *Sound Waves*. Jolene is an information specialist at the U.S. Geological Survey (USGS) St. Petersburg Coastal and Marine Science Center (SPCMSC) in Florida who served many years as the newsletter's web-layout editor. Assisting Jolene is current *Sound Waves* web-layout editor **Betsy Boynton**, a multimedia specialist in the St. Pete center who is now also doing the newsletter's print layout. **Laura Torresan**, the web designer at the Pacific Coastal and Marine Science Center (PCMSC), will continue to be web-review editor. An important behind-the-scenes role is center reviewer, a senior scientist who reviews each article on behalf of the science center hosting the production of *Sound Waves*. SPCMSC Science Advisory team members **Lisa Robbins**, **Hilary Stockdon**, **Jennifer Miselis**, and **Ilsa Kuffner** each will take on that role as a rotating assignment.

Jolene, Betsy, Laura, and the Science Advisory team members are taking over from the production team based at the USGS Pacific Coastal and Marine Science Center (PCMSC) in Santa Cruz, California: **Helen Gibbons**, who served as *Sound Waves* editor from 2002 to 2015; **Alan Allwardt**, assistant editor; **Susan Mayfield** and **Sara Boore**, who shared print-layout duties; and **Eric Geist**, PCMSC reviewer.

"*Sound Waves* is a vital communication vehicle for USGS researchers who work in ocean and coastal environments. The Pacific Coastal and Marine Science Center has done a phenomenal job leading the production of the newsletter for nearly 14 years, growing it into a publication that represents the scope and breadth of USGS research conducted by many science centers," said **Susan Russell-Robinson**, Acting Program Coordinator of the USGS Coastal and Marine Geology Program (<**http://marine.usgs.gov/**>), which funds production of the newsletter. "I am excited to see the transition of production leadership to the staff of the St. Petersburg Coastal and Marine Science Center, because it represents an excellent example of succession planning to sustain *Sound Waves*. This change offers opportunities for trying new ideas for producing an electronic publication and for engaging even more widely across USGS and it partners. Thanks to Helen and her team! And best wishes to Jolene and her team!"

Sound Waves has been published online at <**http://soundwaves.usgs.gov/**> since 1999 by the Coastal and Marine Geology Program. It highlights USGS-wide research and related activities in the nation's oceans, coasts, and Great Lakes. Contributions from USGS employees in all centers

Laura Torresan and Jolene Gittens.

are invited; please submit articles to your center's contributing editor or directly to **Jolene Gittens**, **jgittens@usgs.gov**. The current contributing editors are **Dennis Krohn** (SPCMSC), **Helen Gibbons** (PCMSC), **Susan Verner** (Woods Hole Coastal and Marine Science Center), **Sandra Morrison** (Midwest Region), **Josh Miller** (Great Lakes Science Center), **Gabrielle Boudreaux Bodin** (National Wetlands Research Center), and **Xochitl Rojas-Rocha** (Western Ecological Research Center). Please contact Jolene if your center does not have a contributing editor and you are interested in serving in that role, which entails collecting and forwarding articles from center employees. ❁

Recent Publications

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(Publications continued on page 15)

(Publications continued from page 14)

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